

Determining range readiness and growing degree-days (GDDs)



RANGELAND HEALTH BROCHURE 11



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Citation

Fraser, D.A. 2006. Determining range readiness and growing degree-days (GDDs). B.C. Min. For. Range, Range Br., Kamloops, B.C. Rangeland Health Brochure 11. URL: <http://www.for.gov.bc.ca/hra>

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Acknowledgement

Thank you to MOFR Protection Branch for the use of the automated fire weather station photo found on page 2.

Cover image

Saskatoon in full bloom.

Growing degree-days

Researchers¹ in North Dakota have correlated leaf-stage development with growing degree-days (GDDs) in several native and introduced grass species. Their findings allow range managers with large districts to supplement field observations with mean daily temperature data from local weather stations to determine when various spring “turn-out” pastures will be ready for grazing in a given year.

The modified procedure for British Columbia is as follows:

- After a pasture is snow-free, and beginning not earlier than March 1 on the coast, March 15 in the southern interior, and April 1 in the remainder of the province, there must be 5 consecutive days when the daily average temperature exceeds 0°C before GDDs begin to accumulate. This is referred to as “start-up.”
- GDDs are calculated by the formula: $(\text{daily max.} + \text{daily min.})/2 - 0^\circ\text{C} = \text{___ GDDs}$.
- If, after start-up, the mean daily temperature does not reach 0°C for 1 or more days, enter 0 in the form for those days so as not to

affect the accumulated GDD total. Do not enter a negative number. When the mean daily temperature again exceeds 0°C, the GDDs will accumulate from where they stopped.

North Dakota has information on junegrass, needle-and-thread, green needlegrass, western wheatgrass, and crested wheatgrass (Appendix 3).

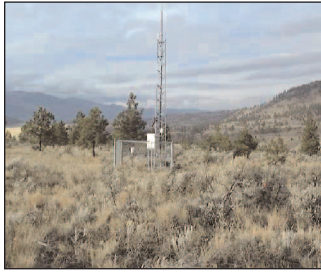


Early spring range in the Central Cariboo.

1 Frank, A.B and L. Hofmann. 1989. Relationship among grazing management, growing degree-days, and morphological development for native grasses on the Northern Great Plains. *J. Range Manage.* 42(3): 199–202.

Frank, A.B. 1996. Evaluating grass development for grazing management. *Rangelands* 18(3): 106–109.

Frank, A.B., K.K. Sedivec, and L. Hofmann. 1993. Determining grazing readiness for native and tame pastures. North Dakota State University, Extension Service, Fargo, N.Dak. R-1061.



Afton automated weather station.

The B.C. Ministry of Forests and Range maintains a network of automated fire weather stations that may provide an opportunity for people wishing to correlate the GDD concept with grass leaf-stage development. See the following websites:

<http://www.for.gov.bc.ca/protect/weather/stations.htm>

<http://fshprw1.hpr.for.gov.bc.ca/Scripts/Public/Common/Report.asp?Report=Daily>

Stations of particular interest to range managers are those:

- at lower to middle elevations;
- on south and southwest aspects; and
- in grasslands, shrublands, and open forested types.

Many of these sites coincide well with range readiness turn-out pastures, as these are the first areas to become snow-free, to have spring plant growth and dry-out, and to become a fire hazard.

Daily maximum and minimum temperatures for key weather stations at lower elevations can be obtained beginning in mid-March to early April of each year. These data can be fed into an Excel spreadsheet by locality and grass species. When the accumulated GDDs are reached for the grass species in that pasture unit, the area is approaching range readiness.

The North Dakota research in mixed-grass prairie showed that past management and level of use had no appreciable effect on leaf development. However, observations of bunchgrass range in British Columbia show an apparent difference in leaf-stage development when comparing lightly grazed plants to heavily/severely grazed plants.

In the Rocky Mountain Trench in 2003, lightly grazed rough fescue and bluebunch wheatgrass plants were phenologically 1.5–2.0 leaves ahead of neighbouring heavily grazed plants of the same species.

Why the difference? The lightly grazed plants had more standing litter and therefore better insulation around the new tillers. This insulation buffered the plants from the temperature extremes experienced in spring, particularly at night when heat loss can be significant. This resulted in higher effective GDDs for the lightly grazed plants and translated to higher leaf numbers.

There is a need to gather and correlate GDD data to leaf stage for important grass species in British Columbia, and to supplement the information from North Dakota. These species are listed in Table 1. Refer to the range readiness criteria brochure² for procedures on sampling and determining leaf-stage development, and for appropriate leaf stage by grass species. Ideally, specific plants should be tagged and revisited over the course of the growing season, and leaf stage should be recorded on each visit.

You can use either the attached Excel spreadsheet in Appendix 1 or enter the information manually into the table in Appendix 2. Excel provides a running total of GDDs.

Please contact me, Doug Fraser, if you are interested in participating in a project. If there is enough interest, a GDD/range readiness network could be developed for British Columbia.



Livestock on early spring range.

² Fraser, D.A. 2004. Using range readiness criteria. B.C. Ministry of Forests, Victoria, B.C. Rangeland Health Brochure 5.

Table 1 Important grass species in British Columbia, tabulated by Forest Region

Forest Region	Species
Coastal Region (CR)	Orchardgrass Ryegrass – perennial and Italian Wildrye, blue
Southern Interior Region (SIR)	Fescue, Idaho Fescue, rough Hairgrass, tufted Junegrass Needlegrass – Columbia, green, and stiff Needlegrass – needle-and-thread Needlegrass – porcupine grass Orchardgrass Pinegrass Wheatgrass, bluebunch Wheatgrass, crested Wheatgrass, western
Northern Interior Region (NIR)	Bluejoint (Canada reedgrass) Brome grass – smooth and meadow Fescue, Altai Needlegrass – needle-and-thread Needlegrass – porcupine grass Timothy Wheatgrass, northern Wildrye, blue Wildrye, hairy



Bluebunch wheatgrass is in the 3.75-leaf-stage and balsam root is 70% in bloom.

Appendix 1 Excel spreadsheet

Depending on locality, begin recording daily mean temperatures when pastures are snow-free, but not earlier than March 1 on the coast, March 15 in the southern interior, and April 1 in the remainder of the province.

The Excel spreadsheet has a formula allowing the entry of actual mean daily temperatures even if they are below 0°C. There must be 5 consecutive days with mean daily temperatures greater than 0°C before Excel will begin to accumulate GDDs at start-up. If, after start-up, the mean daily temperature does not reach 0°C for 1 or more days, the accumulated GDD total will not be affected. When the mean daily temperature again exceeds 0°C, the GDDs will accumulate from where they left off. When the target GDDs (if any) are reached, Excel will shade the field from that day onward.

It is important to complement GDD data with field observations. Ideally, specific plants should be tagged and revisited over the course of the growing season, and leaf stage should be recorded on each visit.



Determining range readiness and growing degree-days (GDDs)

Example: Accumulated Growing Degree-Days (interactive form at <http://www.for.gov.bc.ca/hfd/pubs/docs/Bro/Bro84/GDD.xls>)

Year: 2003 Weather Station: Airport

Aspect: SW

Elevation: _____

Range Unit/Pasture: _____

Indicator Grass Species:

RCO

RNI

RSI

Required GDDs: 290

Day	March			April			Mean Daily Temp.
	Mean Daily Temp.	Accumulated GDDs	Leaf No.	Mean Daily Temp.	Accumulated GDDs	Leaf No.	
1		0		7	72		10
2		0		8	80		10
3		0		9	89		12
4		0		6	95		15
5		0		8	103		12
6		0		9	112		10
7		0		10	122		9
8		0		9	131		10
9		0		9	140		16
10		0		11	151		16
11		0		9	160		16
12		0		8	168		16
13		0		10	178		16
14		0		10	188		15
15	0	0		8	196		16
16	-1	0		12	208		18
17	2	0		4	212		18
18	3	0		9	221		15
19	0	0		10	231		14
20	4	0		14	245		15
21	0	0		15	260		18
22	0	0		12	272		18
23	5	5		12	284		15
24	7	12		12	296		14
25	7	19		4	300		14
26	8	27		8	308		14
27	8	35		10	318		15
28	7	42		10	328		15
29	6	48		10	338		15
30	8	56		12	350		16
31	9	65					17
Total		65			350		

UTM: _____

Leaf No. #VALUE!

Leaf No. #VALUE!

crested Leaf No. 3.5

May		June			July		
Accumulated GDDs	Leaf No.	Mean Daily Temp.	Accumulated GDDs	Leaf No.	Mean Daily Temp.	Accumulated GDDs	Leaf No.
360			800			800	
370			800			800	
382			800			800	
397			800			800	
409			800			800	
419			800			800	
428			800			800	
438			800			800	
454			800			800	
470			800			800	
486			800			800	
502			800			800	
518			800			800	
533			800			800	
549			800			800	
567			800			800	
585			800			800	
600			800			800	
614			800			800	
629			800			800	
647			800			800	
665			800			800	
680			800			800	
694			800			800	
708			800			800	
722			800			800	
737			800			800	
752			800			800	
767			800			800	
783			800			800	
800			800			800	
800			800			800	

Appendix 2 Manual calculations

Accumulated Growing Degree-Days for the Year: _____
Station: _____ UTM: _____ Aspect: _____ Elevation: _____
Range Unit/Pasture: _____ Utilization Level: _____
Indicator Grass Species: _____ Leaf Stage: _____ GDDs: _____

Depending on locality, begin recording daily mean temperatures when pastures are snow-free, but not earlier than March 1 on the coast, March 15 in the southern interior, and April 1 in the remainder of the province. There must be 5 consecutive days with mean daily temperatures greater than 0°C before beginning to accumulate GDDs at start-up. Enter the mean daily temperature in °C and add until GDDs for the grass species are reached.

If, after start-up, the mean daily temperature does not reach 0°C for 1 or more days, enter 0 in the form for those days so as not to affect the accumulated GDD total. Do not enter a negative number. When the mean daily temperature again exceeds 0°C, the GDDs will accumulate from where they left off.

It is important to complement GDD data with field observations. Ideally, specific plants should be tagged and revisited over the course of the growing season, and leaf stage should be recorded on each visit.

Open south exposures are the first to green-up in spring.



Year _____

Day	March		April		May		June		July	
	Temp	Leaf	Temp	Leaf	Temp	Leaf	Temp	Leaf	Temp	Leaf
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
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24										
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26										
27										
28										
29										
30										
31										
Σ										

Σ >/ GDDs on _____
(date)

Appendix 3 Range readiness by leaf stage and by GDDs

Species	Readiness Criteria	Estimated GDDs
Native		
Bluejoint (Canada reedgrass)	4.0	
Fescue, Altai	4.5	1190
Fescue, Idaho	4.0	1070
Fescue, rough	4.5	1190
Hairgrass, tufted	4.0	
Junegrass	4.0	520
Needlegrass – Columbia, green, and stiff	3.0	580
Needlegrass – needle-and-thread	3.0	525
Needlegrass – porcupine grass	3.0	600
Pinegrass	2.25–2.5	
Wheatgrass, bluebunch	4.0	830
Wheatgrass, northern	5.5	1100
Wheatgrass, western	4.0	770
Wildrye, blue	4.0	
Wildrye, hairy	4.0	
Introduced		
Bromegrass – meadow and smooth	3.0	375
Orchardgrass	3.0	
Ryegrass – Italian and perennial	4.0	
Timothy		
Wheatgrass, crested	3.5	290



A bluebunch wheatgrass tiller in the 4-leaf stage.

Note: Readiness criteria and GDDs requiring validations are highlighted.

